Rotational-like Properties of the Shears Bands†

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In previous works[1] we have presented a semi-classical analysis of the shears mechanism and suggested that the rotational-like characteristics of these M1 bands can be understood in terms of an effective interaction of a $P_2(\theta)$ type. Here, we study the dynamical properties of the system that follow from the relationship between the total angular momentum I and the rotational frequency ω. Recalling that $\omega = dE/dI$ and from $E(I) = V_2 P_2(\theta(I))$ we obtain

$$\left(\frac{I}{2j}\right) = \frac{1}{2(\frac{I}{2j})^2 - 1}\left(\frac{\omega}{\frac{6V_2}{j}}\right) \tag{1}$$

which suggests the existence of natural units for angular momentum $(2j)$ and rotational frequency $(6|V_2|/j)$, representing the maximum available spin and the maximum rotational frequency, respectively.

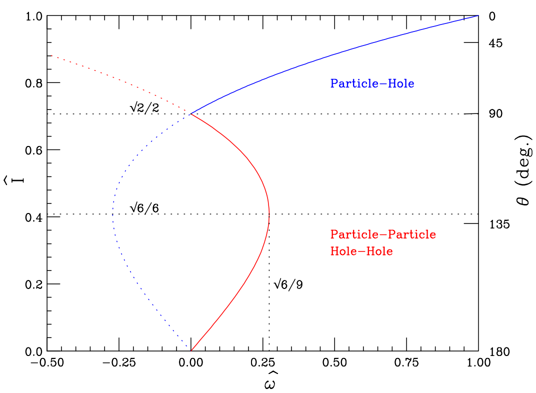

Figure 1: Reduced angular momentum vs. reduced rotational-frequency diagram. The shears angle is given on the scale at right.

For a more detailed analysis we study the behavior of the kinematical and dynamical moments of inertia, which are easily evaluated from Eq. (1) with the familiar definitions

$$\mathcal{J}^{(1)} = I/\omega \quad \mathcal{J}^{(2)} = dI/d\omega \tag{2}$$

As for I and ω, there is also a natural unit for the moments of inertia given by $j^2/3|V_2|$.

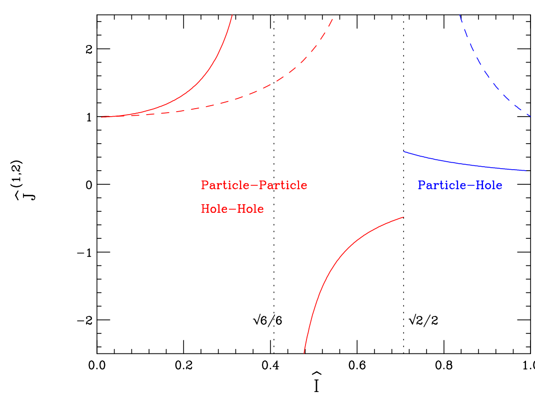

Figure 2: Reduced kinematical(dashed lines) and dynamical(solid lines) moments of inertia as a function of the reduced angular momentum.

The important features can be summarized as follows: *i)* In the particle-particle case both $\hat{\mathcal{J}}^{(1)}$ and $\hat{\mathcal{J}}^{(2)}$ increase with angular momentum. The discontinuity in $\hat{\mathcal{J}}^{(2)}$ at $\hat{I} = \sqrt{6}/6$ is, of course, a consequence of the backbending. *ii)* Because there is an initial alignment in the particle-hole case, $\hat{\mathcal{J}}^{(1)}$ diverges at $\hat{I} = \sqrt{2}/2$, and both $\hat{\mathcal{J}}^{(1)}$ and $\hat{\mathcal{J}}^{(2)}$ decrease with angular momentum. *iii)* An interesting prediction of this model is that at low rotational frequencies the moment of inertia for the particle-particle channel is exactly twice that of the particle-hole channel.

The analytical properties derived above compare well with the experimental observations in the Pb region.

References

† Phys. Rev. **C58** (1998) 3746.

[1] A.O.Macchiavelli et al., *Phys. Rev.* **C57** R1073 (1998), and *Phys. Rev.* **C58** R621 (1998).